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THE ROOT ROT PROBLEM IN THE NORTHERN REGION

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INTRODUCTION

Root rots cause considerable mortality and growth loss in timber-producing areas of the United States. In the eastern and southern parts of the United States, observations from systematic disease surveys during the past 2 decades indicate that annosus root rot caused by Fomes annosus (Fr.) Cooke, is becoming increasingly significant as a limiting factor in intensive management of conifer plantations (3, 6, 7, 8)1/. The disease is continuing to build up in thinned and cutover natural stands, and losses are expected to be greater in second and subsequent rotations and thinning. In California, F. annosus has been found in 28 of 58 counties, including all National Forests and several National Parks (1). Also in California, about 8,000 acres of pinyon pine type are seriously infected with black-stain root disease, caused by Verticicladiella wagenerii Kendrick, for which there is no known control. Childs and Shea (4) estimate that root rots result in growth loss of 62 million cubic feet and mortality of 53 million cubic feet annually in Oregon and Washington. They point out that among the root rot fungi, Poria weirii Murr., Armillaria mellea (Vahl ex Fr.) Kummer, and F. annosus are major offenders.

Conifer forests throughout western North America consist mostly of virgin stands and young-growth cutover stands restocked primarily by natural regeneration (2). Plantation forestry in the west is still in its infancy. Artificial regeneration is primarily directed toward reclaiming large

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1/ Numbers in parenthesis refer to the corresponding numbers in the list of references at the end of report.

brush fields and forests destroyed by fire during the first 30 years of this century. Since few of these planted and naturally regenerated stands have had a first thinning, the western forests have not encountered the root rot problems so evident in southeastern United States plantations, and in European plantations where up to 30 to 50 percent losses may occur.

Because of the severity of root rots has been shown to increase with increased management of coniferous stands, and because the Northern Region is in the critical stages of management of reforested areas, it is imperative that information concerning the identification, distribution, impact, and biology of the various root rots be obtained. Management guidelines may then be formulated to prevent intolerable losses caused by root rots in current and future managed forests.

METHODS AND RESULTS

In order to cope with the root rot problem, the Northern Region has established a root rot evaluation which involves the five phases:

1. Identification and familiarization
2. Field diagnosis and distribution
3. Impact surveys
4. Root rot biology and etiology
5. Practical application of root rot information to the benefit of the land manager

This paper is primarily concerned with the first two phases, since they have been nearly completed.

PHASE I.--The first and most important factor in any bioevaluation is the identification of the organisms being evaluated. In the Northern Region it is known or suspected that at least 10 potentially important root rotters are present. These are Poria weirii, Poria subacida (Pk.) Sacc., A. mellea, F. annosus, Polyporus anceps Pk., Polyporus schweinitzii Fr., Polyporus tomentosus Fr., Rhizinia undulata Fr., V. wagenerii and Sparassis radicata Weir.

Identification of the various root rots can be accomplished by using fructifications (conks) when available, decay characteristics, and in vitro cultural characteristics. Although decay characteristics as well as fructifications are useful in root rot identification, primary emphasis was placed upon cultural identification as it is, in many cases, the most reliable means for positive identification.

To become familiar with identifying cultural characteristics it was logical to obtain and study known cultures of the aforementioned root rotters (i.e., go from known to unknown). Cultures were obtained from various sources around the United States. These were subcultured on a standard medium under standard conditions and examined periodically to observe cultural growth characteristics and microscopic structures. Following this familiarization, wood chips obtained from decayed roots could be cultured, with cultures subsequently being compared to known cultures. In this way, even though decay columns were characteristic for a given root rot, vertification or positive identification could be made.

Fructifications and decays were studied in order to complement cultural identification. Various stages of decay were then associated with the cultures, so that field identifications using decay columns were more certain of being correct.

PHASE II.--Tree mortality in the Northern Region is frequently caused by numerous insects and fungi including the root rot fungi. But how can one identify root rot areas in the field, particularly since signs of the rot are frequently underground? Again, one must go from the known to the unknown.

Each National Forest and Park within the Region was requested to submit locations of known or possible root rot areas. Also requested was information regarding stand age, stand type, site index, and stand activity (i.e., thinning and/or pruning) in these areas. Approximately 75 to 80 areas were reported and most have been examined. Gross symptoms of the various decays displayed by hosts in all stages of decay were observed and associated with accompanying stages of wood decay. Laboratory isolations were also made to provide positive identification of the root rot involved.

After examining a number of the known root rot areas, previously unidentified root rot areas were identified with reasonable accuracy.

Distribution information became available with the examination of the 75 to 80 known and numerous other root rot areas found during the preliminary examinations. An attempt was made to classify each area according to habitat type, aspect, and precipitation whenever possible.

In general, the major root rot areas in Region 1 were found to lie west of the Continental Divide, consequently most of the work has been done on west side Forests.

Armillaria mellea is endemic to most or all forested areas in the Northern Region. Thus, it is not surprising that it has been found in all areas, and on all tree species examined. Severity of the root rot varies from single tree mortality, to selecting and killing a single species, to causing large or small root rot centers where all species are attacked. However, it is mostly confined to causing single tree or single species mortality, particularly in P. ponderosa Dougl. plantations.

A. mellea usually attacks trees which are growing under stress. This would explain the single tree and/or species selectivity it shows, as it attacks those trees not growing well or unsuited for the area. In the case of large root rot centers where all species are attacked, the organism is apparently "turned on" becoming more virulent so that even "healthy" trees are attacked.

Field identification of A. mellea is quite easy, but caution must be exercised in making a diagnosis as it can occur on the same host with other more virulent root rotters.

Poria weirii has been found on Pseudotsuga menziesii (Mirb.) Franco, Abies grandis Lind., Thuja plicata D. Don, and P. ponderosa, but is most common on the first three hosts. It has been reported to occur in Tsuga heterophylla (Raf.) Sarg. and Pinus monticola Dougl. It is most frequently found on the Coeur d'Alene National Forest, but also occurs to a lesser extent on the Kaniksu and St. Joe National Forests. Preliminary evaluations indicate that on non-Thuja plicata hosts, P. weirii is most abundant on the P. menziesii - shrub and A. grandis-Pachistima myrsinites (Pursh) Raf. habitat types (5), and occurs in centers of a few trees up to areas 25 to 30 acres in size. P. weirii is apparently widespread and coextensive with T. plicata throughout its range.

It appears that at least two different types of P. weirii may occur in this Region. These are the Thuja plicata and non-Thuja plicata types. However, this is only an assumption. Inoculation evaluations of the two types on each host class are indicated.

Field identification of P. weirii is fairly easy. Its presence in nearly all cases is enough to consider it as a primary problem.

Fomes annosus has been found in young P. ponderosa plantations on the Colville National Forest, and in mature Abies lasiocarpa (Hook.) Nutt. on the Coeur d'Alene National Forest. Identification was made from cultural isolations as sporophores or characteristic decay was not found. This rotter has not been found with enough frequency to identify it with any habitat type. It is expected that as more thinned plantations are examined, more F. annosus will be found.

Positive identification of the organism can be made in as little as 2 to 3 days by aseptically culturing decayed wood and looking for the characteristic conidial stage.

Polyporus schweinitzii is known to occur in the Region, since the velvet-topped sporophores have been found in most areas on the west side, particularly in those habitat types where P. menziesii, A. grandis, and T. heterophylla are the dominant climax species (5). It has also been found in abundance in mature P. monticola on several areas of the St. Joe National Forest and is known to occur in P. menziesii. It is undoubtedly more common than the initial survey indicated.

Its relative importance as a root rotter in the Region has not been determined at this time.

Verticicladiella has been found in Pinus strobus L. and Pinus contorta Dougl. in several P. strobus plantations on the Kootenai National Forest. Apparently the disease was introduced via the P. strobus planting stock as the rot has been found only in these areas. The possibility exists that V. wageneriі is present in other P. strobus plantations within the Region.

Polyporus tomentosus sporophores have been found on the Coeur d'Alene National Forest. Cultures obtained from decay columns on P. ponderosa growing on the Flathead Indian Reservation have been tentatively identified as P. tomentosus. The rot is easily confused with that caused by Fomes pini (Thore ex Fr.) Karst, and may be of more importance than formerly thought.

Poria subacida and Polyporus anceps are known to occur in the Region; however, their frequency and distribution are not known at the present time.

Other root-rotting fungi are thought to be in the Region and will undoubtedly be found upon more critical examination of the Forests of the Northern Region.

Aerial surveys for root rot were made on the Coeur d'Alene National Forest. Numerous possible root rot areas were located from the air, and confirmation of several as being root rot centers was made. It is felt that root rot areas can be located with reasonable accuracy from the air. This aspect will be expanded in 1972.

FUTURE PLANS

PHASE III.--Extensive statistically based impact surveys will be conducted in the Region, beginning in early 1972. Along with root rot information, data concerning insects, other disease problems, habitat type (5), and other factors of the ecosystem will be collected. It is hoped that correlations can be made which will aid in formulating management guidelines for particular areas.

Aerial detection methods for root rots and other diseases will be more fully explored in 1972. This will involve the use of both high-level color photography to detect and document root rot areas, and low-level infrared (IR) photography to determine extent of root rot infection in individual centers. This will aid the land manager in determining current as well as future losses, and help in determining the rate of spread of the rots. If the use of low-level IR photography can be developed and utilized, it could be used in providing guidelines for determining trees that should be cut in salvage logging operations, and in commercial and precommercial thinning practices.

The Verticicladiella problem will receive close attention in 1972, for if it can be concluded that the fungus is confined to P. strobus plantations, eradication would be well advised. Decisions will be based on planned impact surveys and intensive surveys of P. strobus plantations within the Region.

PHASE IV.--Once the identity, distribution, and impact of root rots are known, we will know what we have, where it is, and how much damage it is causing, but we still need to know how the organisms function under Region 1 environmental conditions. The fulfillment of this need would involve the study of the biology of the various rotters as well as the etiology of the disease. Much information concerning the biology and etiology of root rots can be obtained from available literature. However, since very little work with root rots has been done in the Region, this information would necessarily need confirmation for our conditions. This information could then be used as a basis for evaluating and/or adapting to our conditions any number of control methods which have been developed in other areas.

PHASE V.--Once we obtain all of the above information, we should then be able to formulate management guidelines for timber-producing areas infected with root rot, or be able to predict and prevent spread of the causal agent into adjacent noninfected stands.

For example, F. annosus infection might be curtailed by thinning young stands at the right time of the year. Spread of P. weirii might be reduced by minimizing mechanical injuries during intermediate cuts, and by preventing fires, particularly ground fires which produce wounds at the base of tree trunks. In the case of root rot centers, it may be possible to remove all potential hosts for a given distance around the center and isolate this area or "starve out" the root rot organism. Various new methods of logging could be utilized to reduce inoculum levels in soils.

These are but a few examples of how the information obtained in Phases I through IV could be utilized to the benefit of the land manager.

In short, if the prediction for increasing root rot problems with increased timber management holds true for this Region, as it has in all other areas of the world, we need to obtain as much root rot information as possible, as soon as possible, in order to cope with the imminent root rot problem. Our forests have been under management for a relatively short time, and thus we have the opportunity by learning from others' mistakes and successes, and by using information obtained from our studies to avert the impending root rot hazard.

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